

KiwiSAT

A communications satellite for New Zealand

<http://kiwisat.org/index.html>

Presentation Provided
by

***Kiwisat Project
Leader***

***Fred Kennedy
(ZL1BYP) AND HIS
TEAM***

Presentation for the AMSAT- NA Space
Symposium
24 - 26 October 2008

Presented by
Bill Ress N6GHZ
for AMSAT-ZL



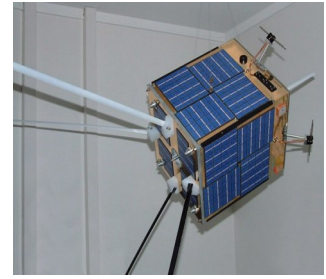
KiwiSAT Project

A New Zealand communications
satellite
for Low Earth Orbit





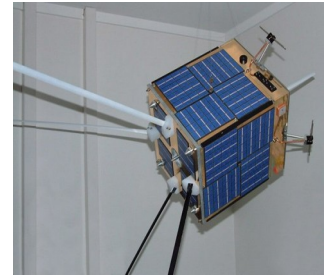
KiwiSAT – Review



- **KiwiSAT** – the first satellite from New Zealand (c/o AMSAT-ZL!) – CubeSAT or MicroSAT?
- CubeSAT – 100 mm cube 1 kg investigated – rejected.
- MicroSAT – 230mm cube accepted for development
- Basic communications fit approved and 90% complete
- Science package determined and under construction.
- Launch agency – SLC Kosmotras (Russia) selected.



Basic design

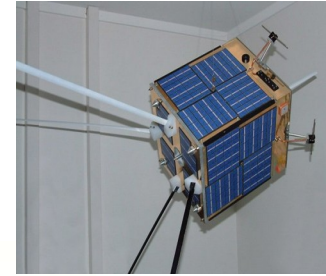


- A MicroSAT class spacecraft cube shaped weighing 10 - 12 kg.
- Six solar panels – one on each surface
- Measuring tape antennas for VHF.
- Stub Monopoles for UHF plus phased folded dipoles for 1.2 GHz receive converter
- Patch antenna for GPS

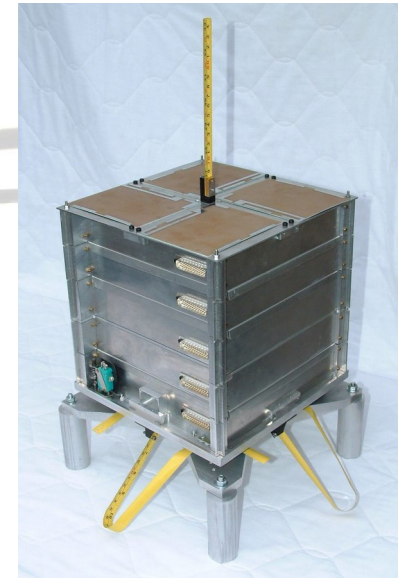


KiwiSAT

Physical structure

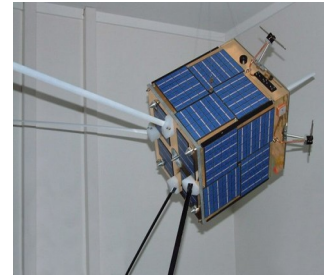


- A stack of five fabricated aluminum trays each 244mm x 244mm + an 'attic' (Reverse tray!)
- The height of each tray varies from 25 - 45mm making a total of 244mm also.
- Nominal useful internal area in each tray is approximately 210mm x 200mm
- RF cables plus a wiring harness carry power, inter-module data, telemetry, and control signals.
- Four rods running the height of the spacecraft bolt the assembly together.
- 70% of Satellite's surface area to be covered by solar cells
- All unused surface area (including "attic") is covered with thermal absorbing or reflective tape..





KiwiSAT - Modules

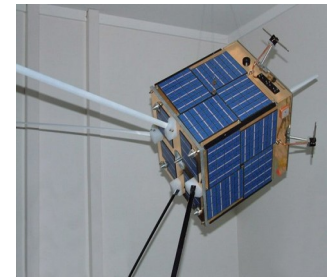


From the top down -

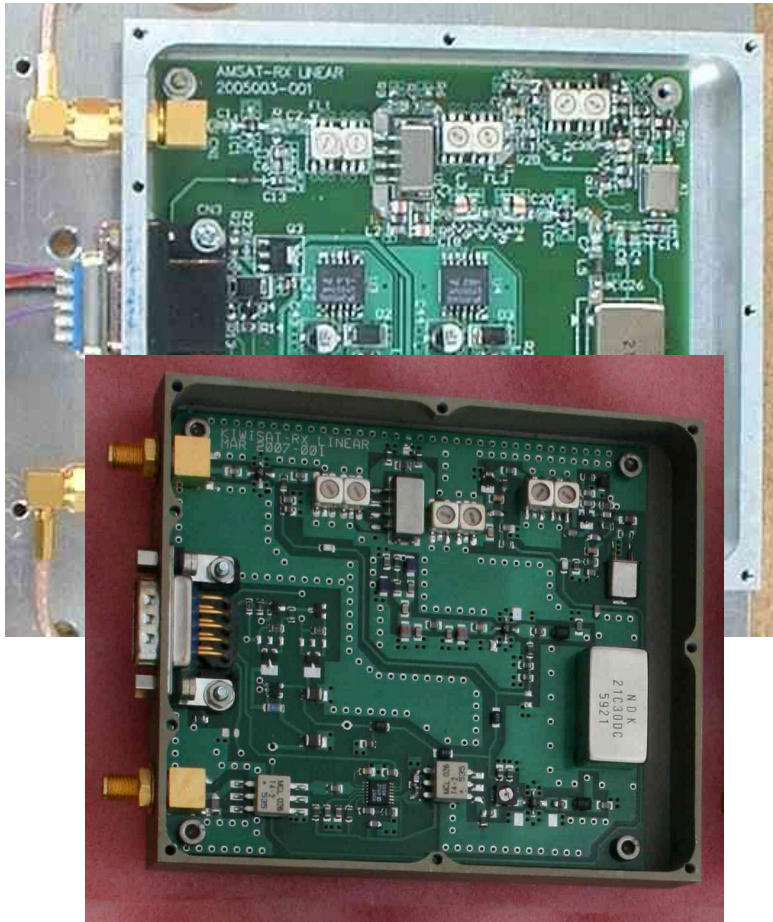
- Receivers on 70 cm and 23 cm and sensors. (+ GPS)
Science package - ADAC using Geomagnetic Field
- IHU (Integrated Housekeeping Unit - Command Computer)
includes 1200 and 9600bd modems
- Battery tray
NiMH battery 4.0 Ah 12 volt
- Battery Charge Regulator (BCR)
- 2 m transmitters (Linear and FM) + U Band Beacon and
target Sun Sensor.



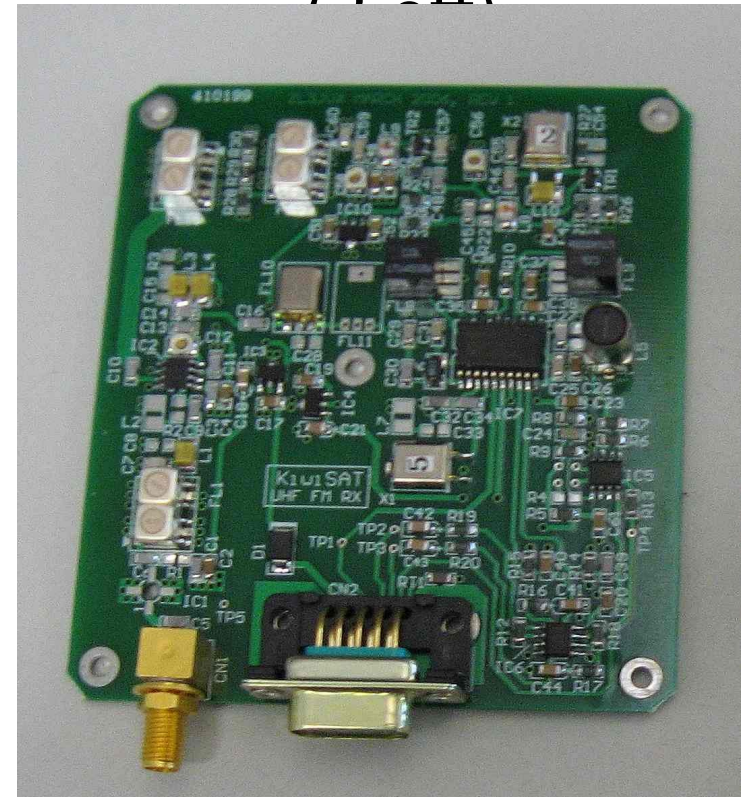
Receivers Linear and FM (& GPS)



Linear - UHF (30 kHz bandwidth)

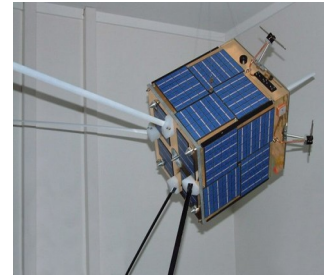


FM -
UHF
(20 kHz)





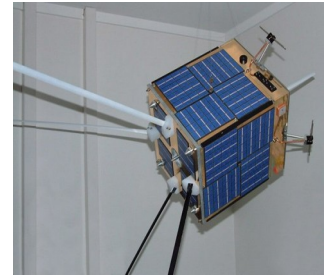
U Band Beacon.



- Needed for Faraday Rotation and TEC measurements for Science Package
- Design/ Schematic is complete.
- PCB layout by Mark (ZL3JVB) is in hand



TRANSPONDER ON TEST!



- The KiwiSAT linear flight transponder is now "on the air" from the Whangaparaoa area with beam antennas pointing South.

* Transponder: Inverting type (Orbital Doppler shift compensation)

* Transmit Power: 2 Watts PEP.

* Beacon frequency: 145.885 MHz

* Uplink: 435.265 to 435.235 MHz **LSB**

* Down link: 145.850 to 145.880 MHz U

* 30 Khz transponder bandwidth



- **Note:** A trial transmission on 435.2544 **LSB** comes out at 145.860 **USB**



Planned Operating

Frequencies

(Subject to licensing confirmation.)

- **Linear Transponder Downlink :**
Frequency: 145.850 MHz to 145.880 MHz.
Output Power: 2 Watts PEP.
Radiated Power: 2 Watts (+33dBm) EIRP PEP.
Bandwidth: 30 KHz. Emission Type: Depends on Uplink: CW, SSB etc.
Antenna pattern: Omni directional in all planes.
- **Linear Transponder Uplink 1 :**
Frequency: 435.260 MHz to 435.230 (Inverting Transponder).
Bandwidth: 30 KHz.
Noise temperature: 273 degrees K.
Emission Type: typically CW, SSB.
Antenna Pattern: Quarter wave whip on +Z face (Omni in X-Y plane, Null in +Z and -Z direction).
- **Linear Transponder Uplink 2 :**
Frequency: 1268.880 to 1268.850 (Inverting Transponder)
Bandwidth: 30 KHz.
Noise temperature: 273 degrees K.
Emission Type: typically CW, SSB.
Antenna Pattern: 4 Dipole array (Omni in X-Y plane, +3 dbi Gain in +Z and -Z direction).



Planned Operating Frequencies

(Cont.)

(Subject to licensing confirmation.)

- **FM and Data Transmitter :**

Frequency: 145.865 MHz.

Output Power: 1 Watt.

Radiated Power: 1 Watt (+30dBm) EIRP.

Bandwidth: 20 KHz.

Emission Type: 9600 bps data (G3RUH Packet standard) Telemetry and Data (various modes) scheduled with FM Voice or 1200 bps AFSK packet telemetry.

Antenna pattern: Omni directional in all planes.

-

F.M Receiver Uplink 1:

Frequency: 435.245 MHz.

Bandwidth: 20 KHz.

Noise temperature: 273 degrees K.

Emission Type: 9600 bps data, FM Voice,

Antenna Pattern: Quarter wave whip on +Z face (Omni in X-Y plane, Null in +Z and -Z direction).



Planned Operating Frequencies

(Cont.)

(Subject to licensing confirmation.)

- **F.M Receiver Uplink 2:**

- **Frequency:** 1268.865 MHz.

- **Bandwidth:** 20 KHz.

- **Noise temperature:** 273 degrees K.

- **Emission Type:** 9600 bps data, FM Voice,

- **Antenna Pattern:** 4 Dipole array (Omni in X-Y plane, +3 dbi Gain in +Z and -Z direction).

- **Beacons:**

- **Beacon 1:**

- **CW Beacon Attached to Linear Transponder:**

- **Frequency:** 145.885 MHz.

- **Emission Type:** CW standard morse code.

- **Power:** 50 mW (+17 dBm) EIRP

- **Beacon 2 (Data Beacon):**

- **Frequency:** 145.865 MHz.

- **Output Power:** 1 Watt.

- **Radiated Power:** 1 Watt (+30 dBm) EIRP.

- **Bandwidth:** 20 KHz.

- **Emission Type:** 9600 bps data (G3RUH Packet standard)
scheduled with 1200 bps AFSK packet telemetry.

- **Beacon 3 (UHF Beacon):**

- **Frequency:** 437.425 MHz.

- **Bandwidth:** 20 KHz.

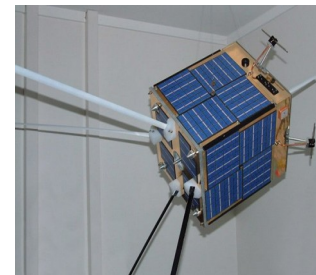
- **Emission Type:** 9600 bps data (G3RUH Packet standard).

- **Radiated Power:** 100 mW (+20 dBm) EIRP.

- **Antenna pattern:** Quarter wave whip on -Z face. (Omni in X-Y plane, Null in +Z and -Z direction).



L Band Converter

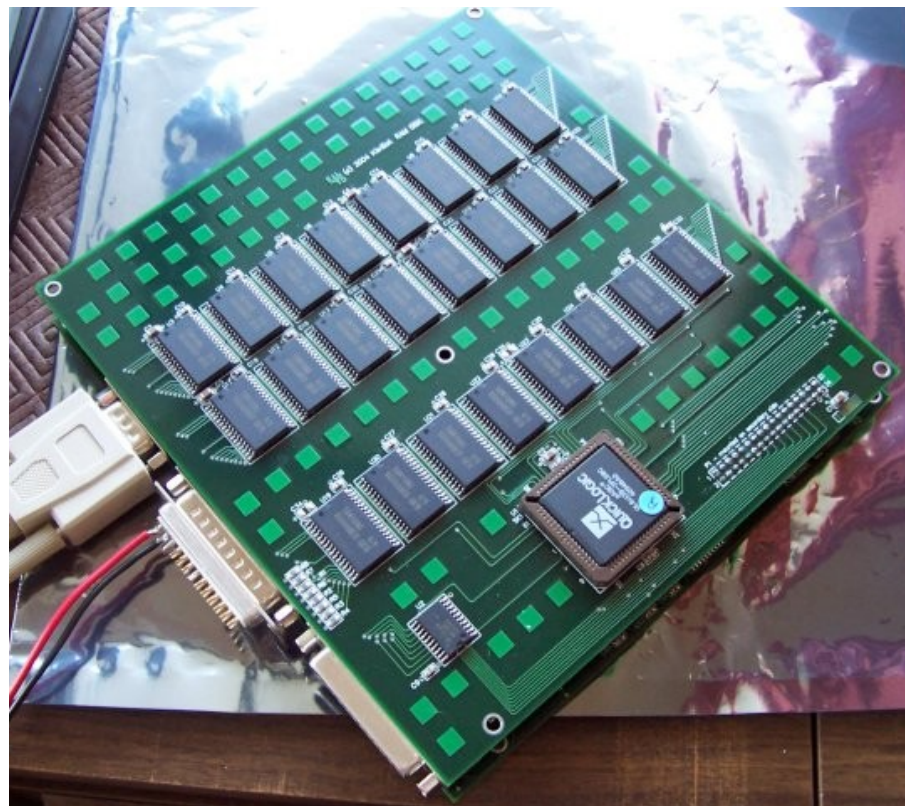


- In hand – Terry (ZL2BAC)
- Awaiting components to complete PCB population.





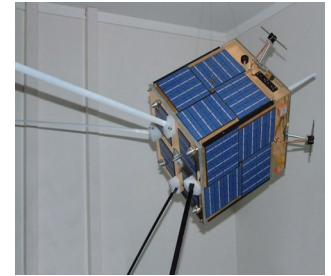
Proto IHU - Computer and RAM Disk



Flight unit is being assembled by Assembly Specialists Ltd. –
our only electronics commercial involvement.
To complete and October 08



Power System

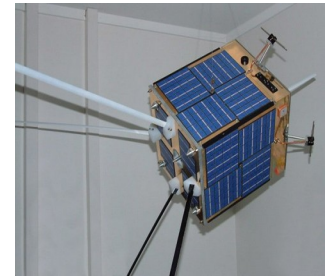


Comprises:-

- **Power generation**
GaAs photovoltaic cells will be used.
- **Battery**
10 x 4.0Ah NiMH cells with a nominal battery voltage of 12 V DC.
- **Battery Charge Regulator (BCR)**
to manage battery charge and protection.



Solar Cells for Flight



**Spectrolab 28% Triple Junction
Cells selected and nearly 30% of
the cost**

**-which was approx. US\$24,000-
was fundraised in NZ.**

**It was “chopped” by ITAR Jan
2005! Will fly 22% GaAs ex**

Tecstar cells

(US\$850 for 200 by way of

Ebay!!!!)

Our thanks to

Dave (G0MRF) – for spotting ‘em.

Bill (N6GHZ) – for nerves of steel bidding for ‘em and

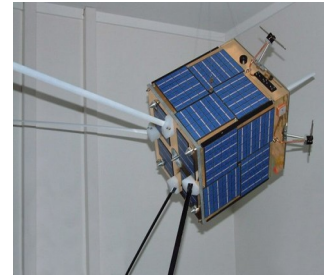
Reinhold – of The Aerospace Corp for sorting out the (free) export
details.



(We owe you, Guys!)



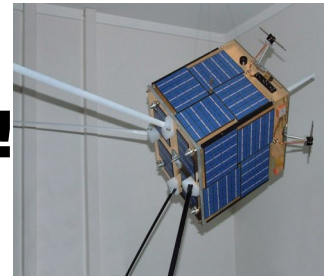
Suitability confirmed and individually rated



where physically possible we 'hands on' test and trial everything

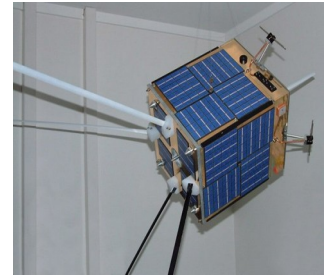


And with the real power source!





Flight Battery

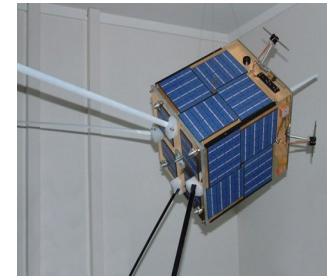


- Capacity requirement – 4.0 Ah at 12 Volts
- Flight ready set of NiMH from AMSAT-DL
- Cells to be stripped, re sleeved with Kapton tape.
- Tefzel ties and Delrin trays fully baked and outgassed.

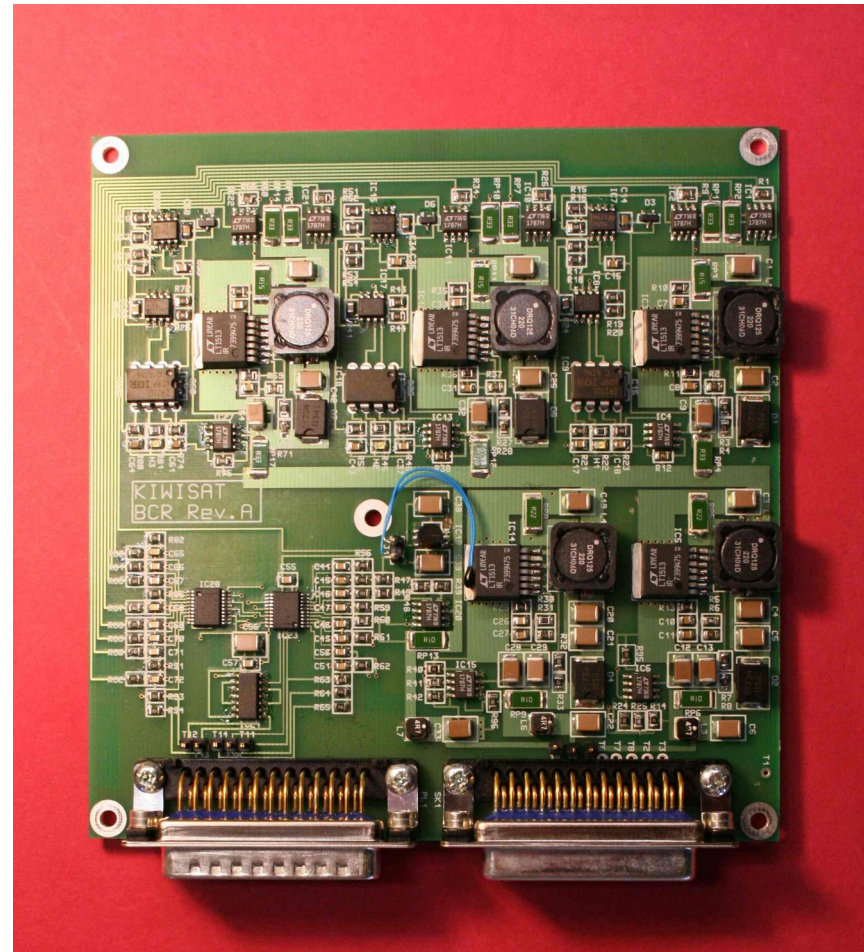




Battery Charge Regulator (Flight Unit.)

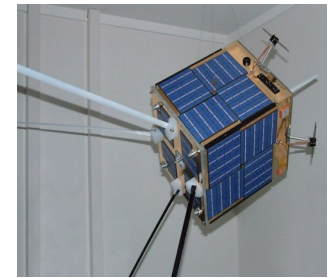


- Switching design by Hans (ZL1HB) - 89% efficiency.
- Operates autonomously.
- CPU to fine-tune default parameters.





Transmitter Linear (Mk 1)



Linear - VHF
(30 kHz bandwidth)
4 Watts.

By Dr Phil Wakeman
of





Transmitter Linear (Mk 2)

**Linear - VHF
(30 kHz
bandwidth)
4 Watts.**

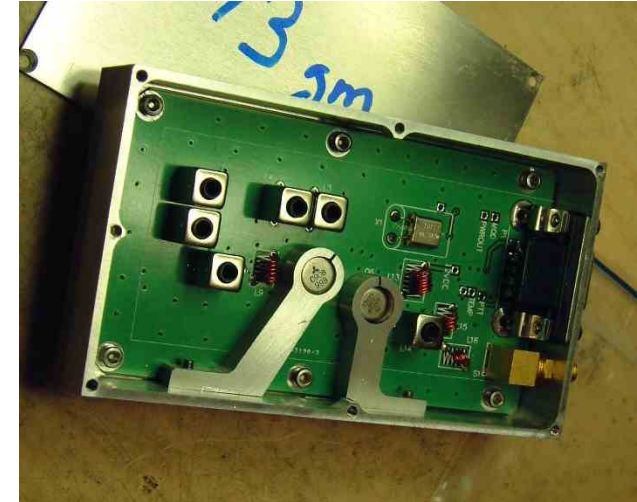
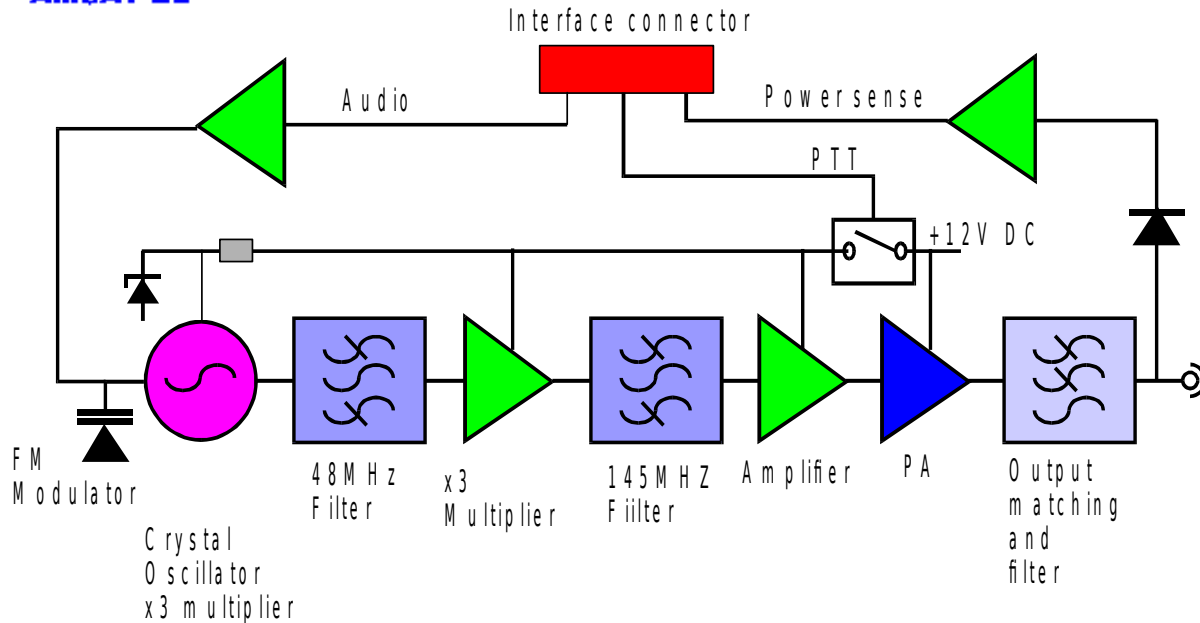
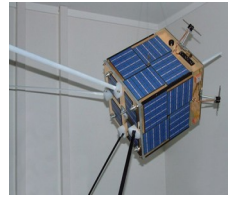
**By Dr Phil Wakeman
of**





Transmitters

FM



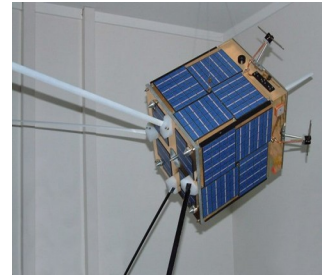
- Frequency 145.865 MHz
- Xtal frequency 16.2072 MHz
- Output power 1W
- Spurious outputs -35 dBc
- DC input 12V at 260 mA
- Modulation FM up to +/-5 kHz
- Temp range -20 +60 degrees C
- Freq stability over temp range +/-10 ppm (1.4 kHz)
- Audio input frequency DC - 15 kHz (-3 dB)



Science Package

orted by_

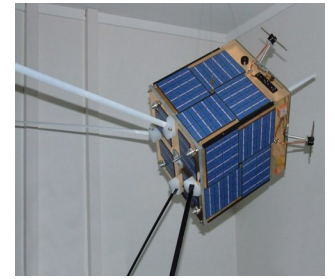
 **Massey University** Auckland



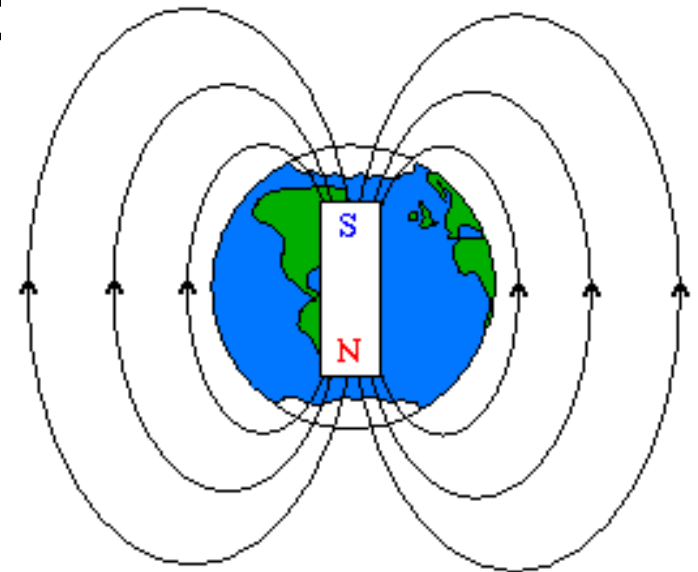
- An Attitude Determination and Control (ADAC) system using the geomagnetic field plus
- a Faraday Rotation and an ionosphere total electron content experiment.



Science Package Attitude Control System.

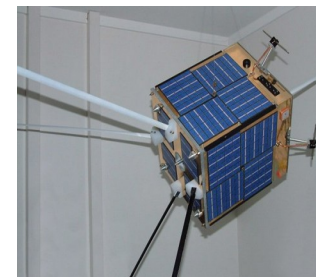


- A 3 axis 'air cored' coil system will be fitted with coils on X,Y and Z faces. These will be energized – as required – providing an active attitude control by interaction with the geomagnetic field'





Attitude Control Test Rig with Magnetometer





Attitude Control Test/Demo. R - draught protected!

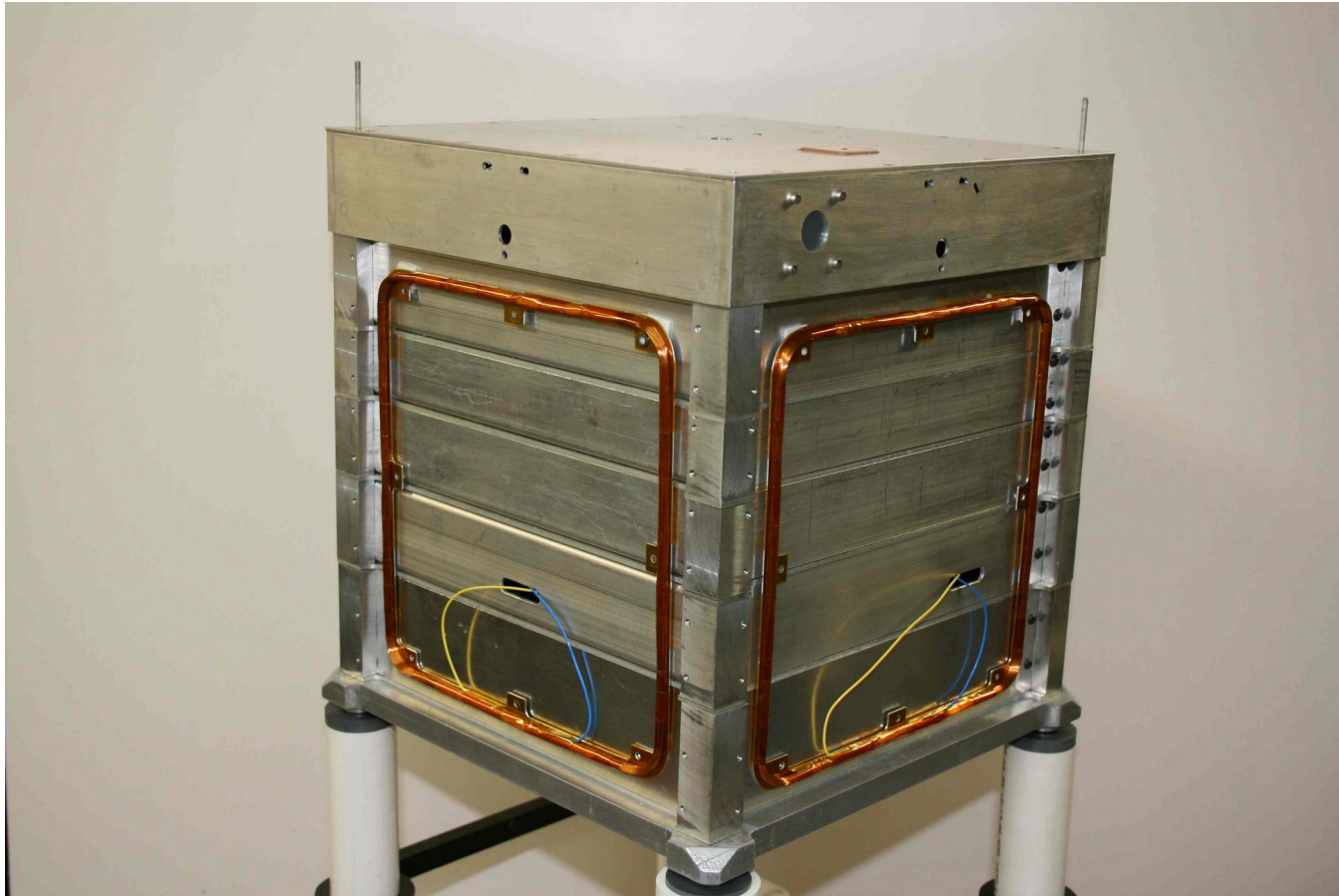
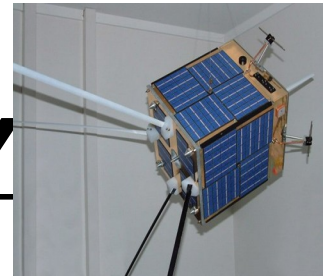


Remote controller.



Torque Coils - X and Y

on engineering mock-up

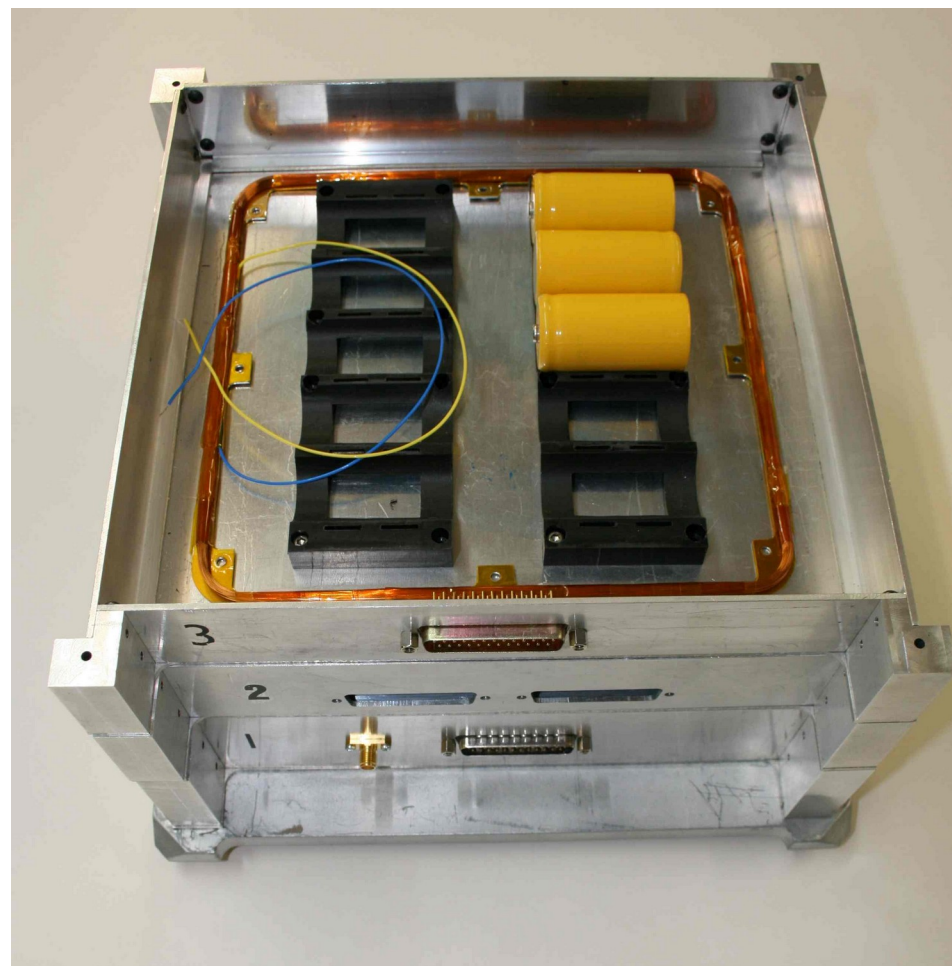
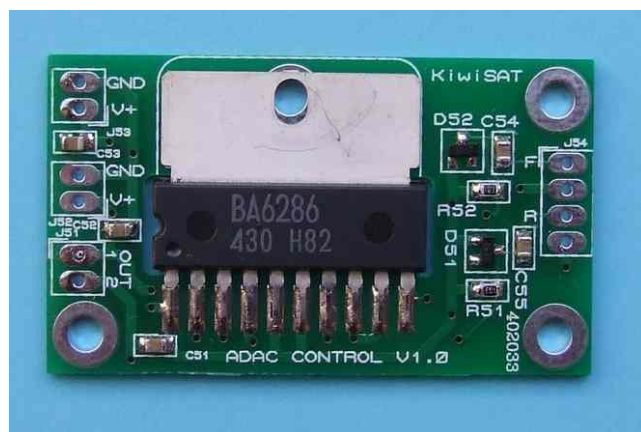




Torque Coil - Z



Located in Tray (No 3)
with the Battery and the
three (X,Y and Z) Coil
Driver PCB's (below)
attached to the tray walls.





Science Package **Attitude Determination** **Sensors**



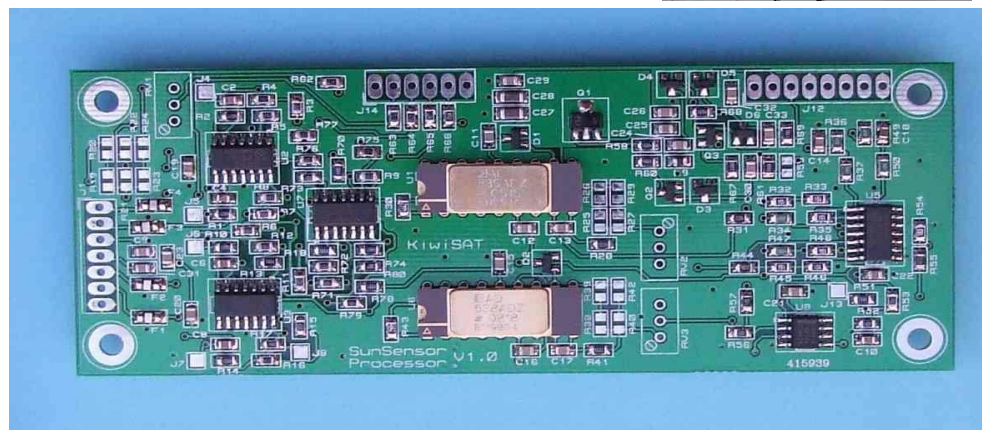
- Sun and Earth/Horizon sensors will provide reference information to 'fix' the satellites position/attitude in space.
- A 3 Axis Magnetometer will record attitude information using the Earths magnetic field.
- A (high speed/altitude) GPS receiver is to be flown for both positional and time data.
- A CMOS fixed focus camera to confirm the attitude -using a horizon image - is being flown.



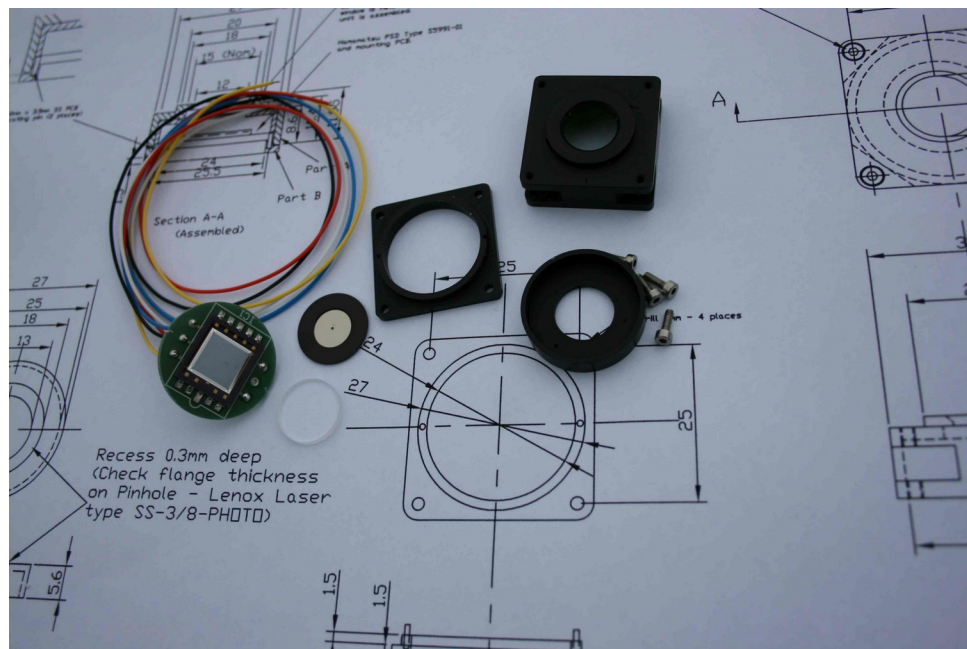
Sun Sensor Processor



- Based on an original circuit by Alan (N1AL) for use in Phase 3D.
- PCB and assembly by Clayton (ZL3TKA)



Sun Sensor Head

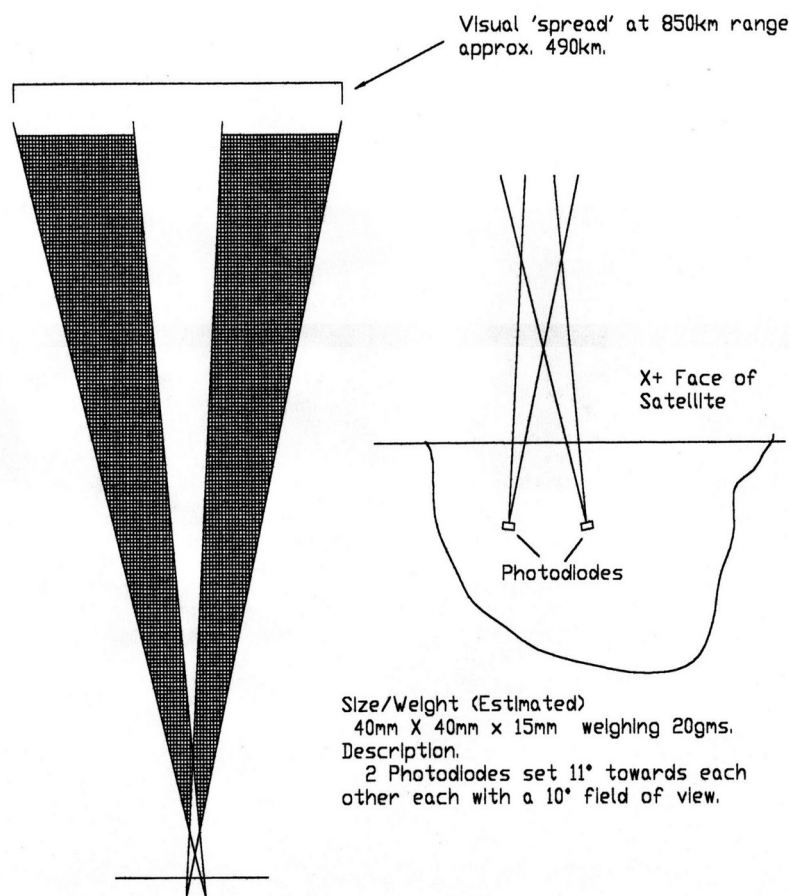
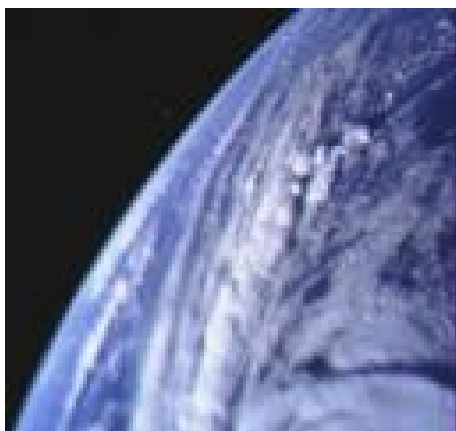




Earth/Horizon Sensors - Fields of view - I/R and Visi

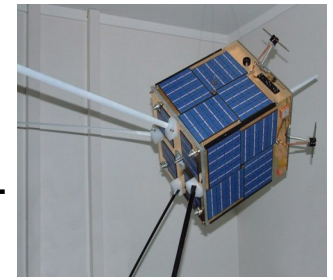


quired to establish the X/Y Axis attitude in relation to the Earth

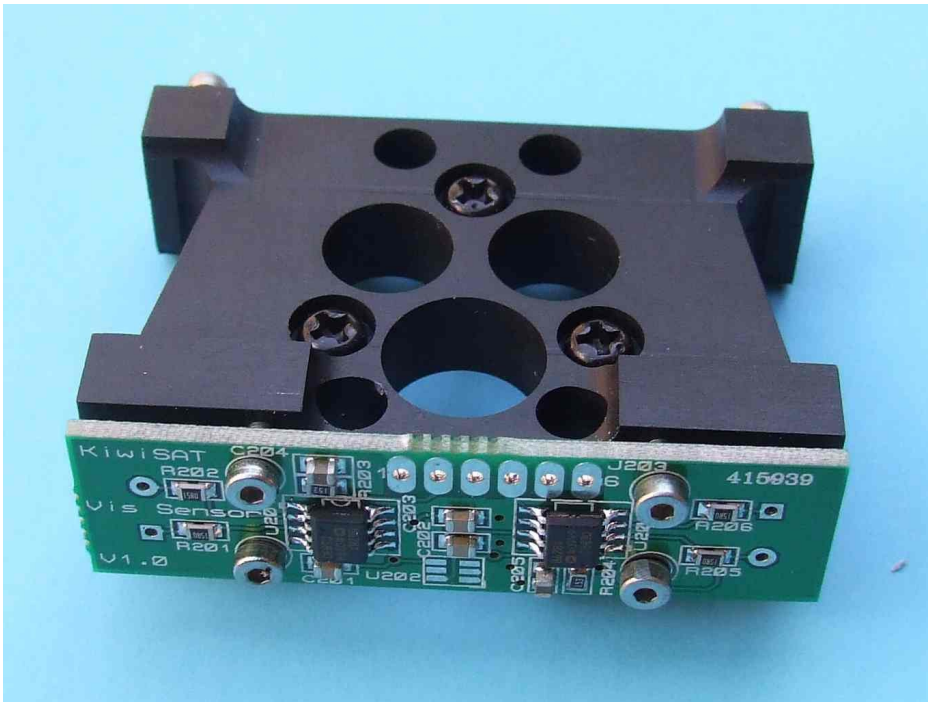




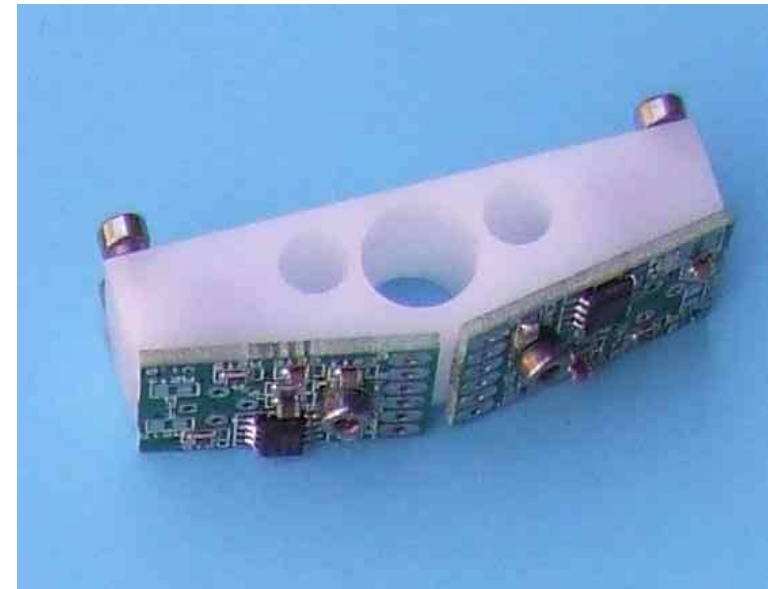
Earth / Horizon Sensors



Heads with sensors for visible and I/R wavelengths.



Visible light head

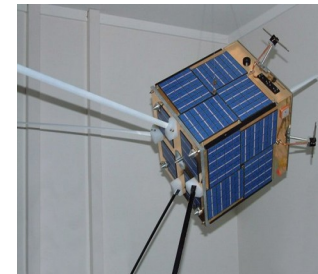


I/R Sensor head

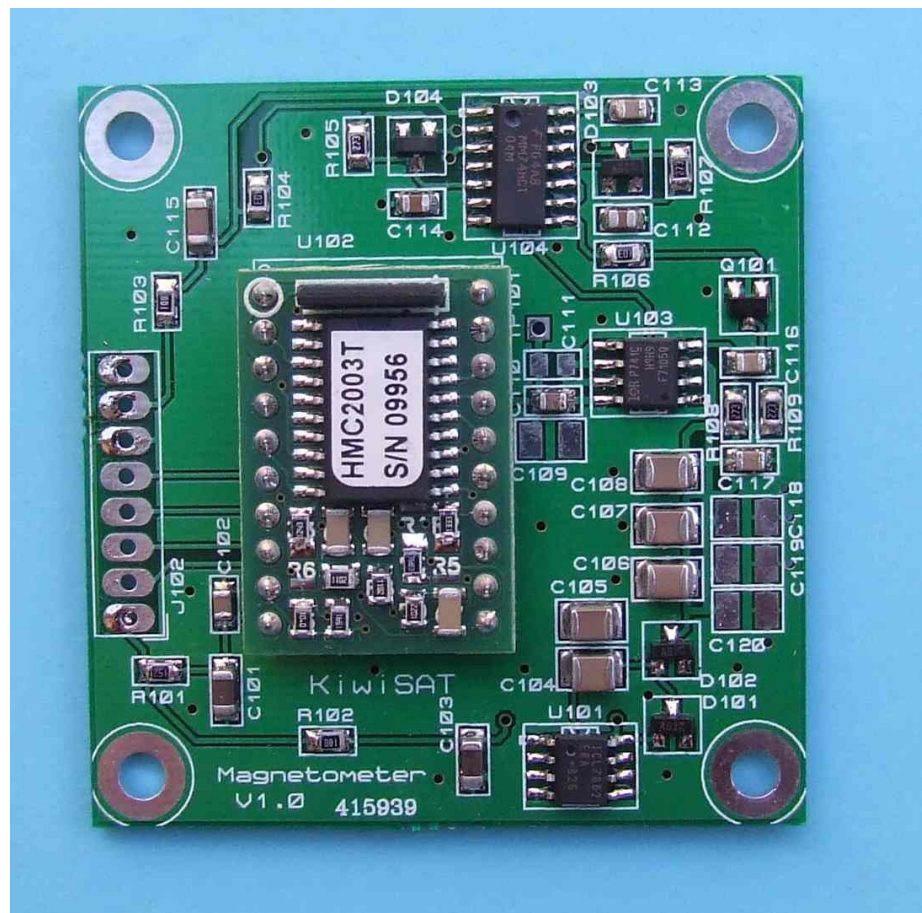
Mounted in the Attic wall on X+ face adjacent the camera.



Magnetometer



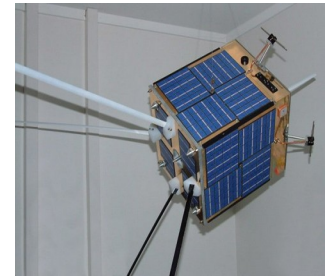
Based on the HMC2003
3 Axis unit from
Honeywell



Adjacent ferrous metal affect test rig,



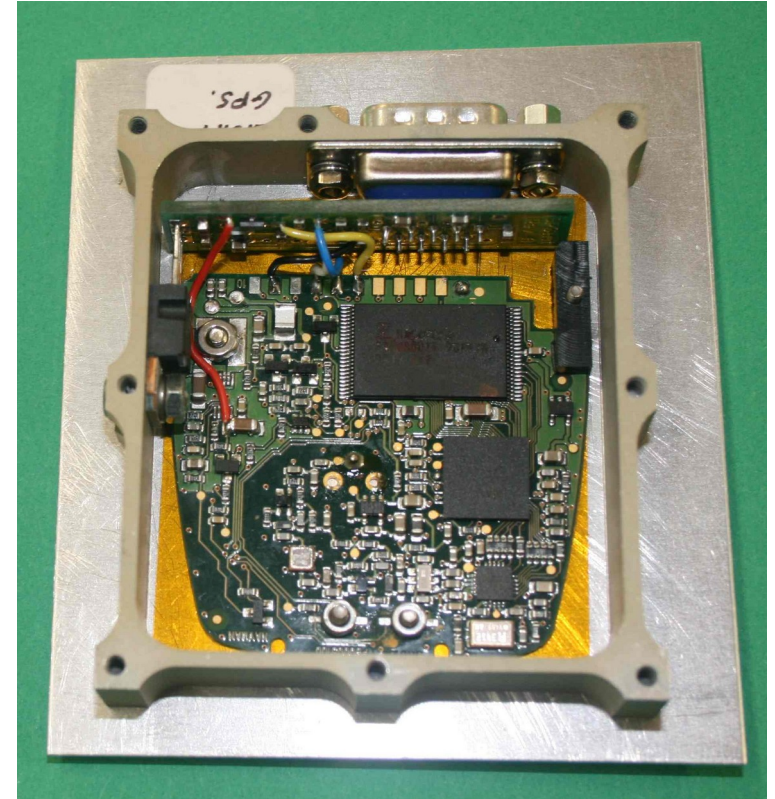
Flight GPS Rx



1. Availability of suitable GPS investigated. NZ \$14,000! (plus ITAR if unit from US!)
2. Out of the question!
3. Three 'old' Navman 'sport' units with duplex port access were found.
4. Enter:
Kelvin (ZL3KB) (Navman)
and programmer Mark (Navman)
5. Dwell a short pause.
6. A fully simulator proven High Altitude, High Speed Flight Unit and two spares ready for thermal vacuum and vibration testing.

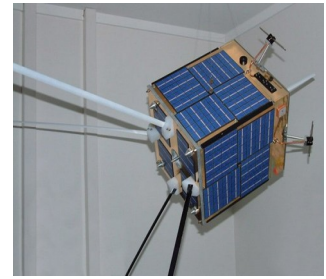
It Passed!

GPS will fly!

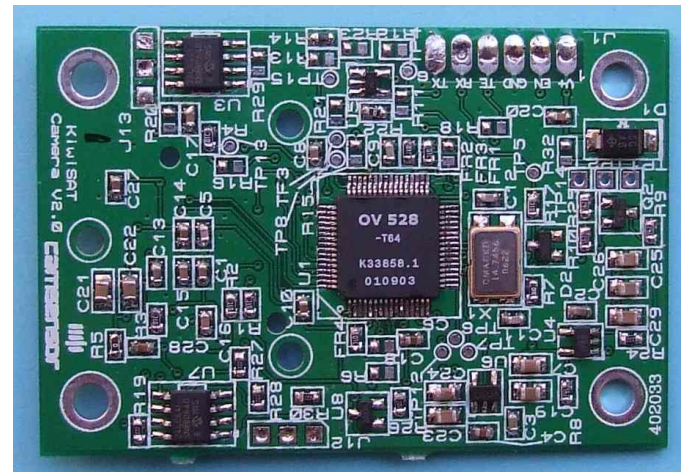
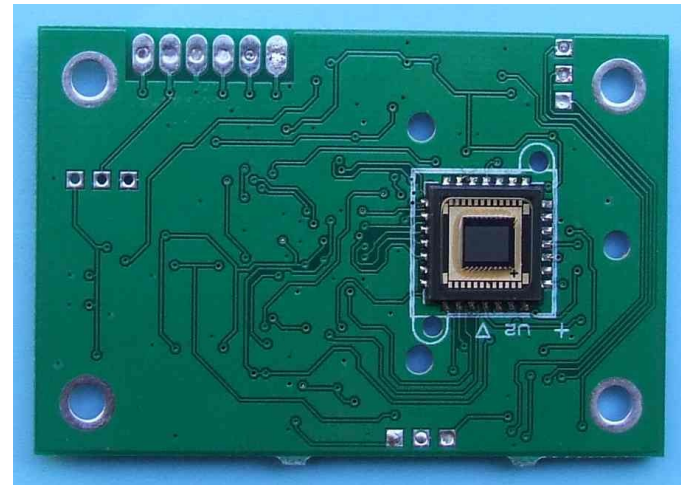




Science Package - Camera

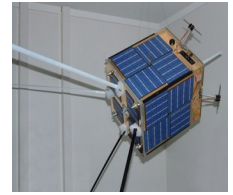


- A small colour camera module has been located via the University of Tokyo. Used on their first CubeSAT XI - IV.
- Re engineered by Clayton (ZL3TKA)
- Camera body - by Fred(ZL1BYP) to follow!!!!

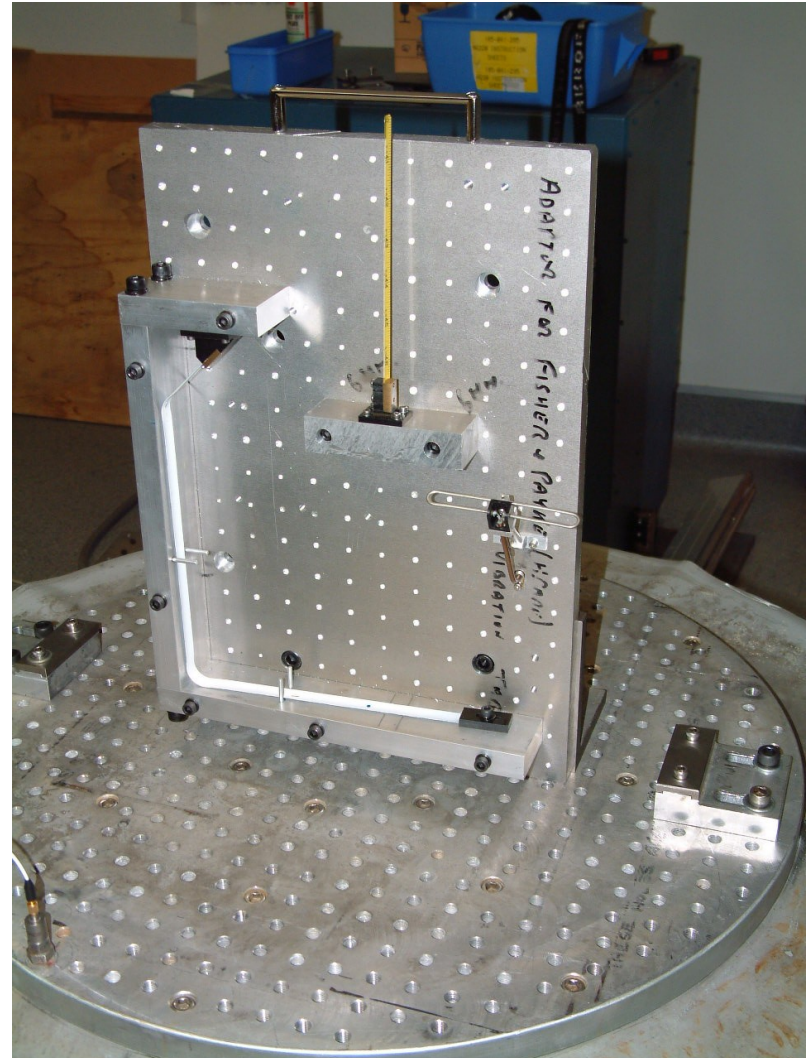




Test Equipment - Vibration

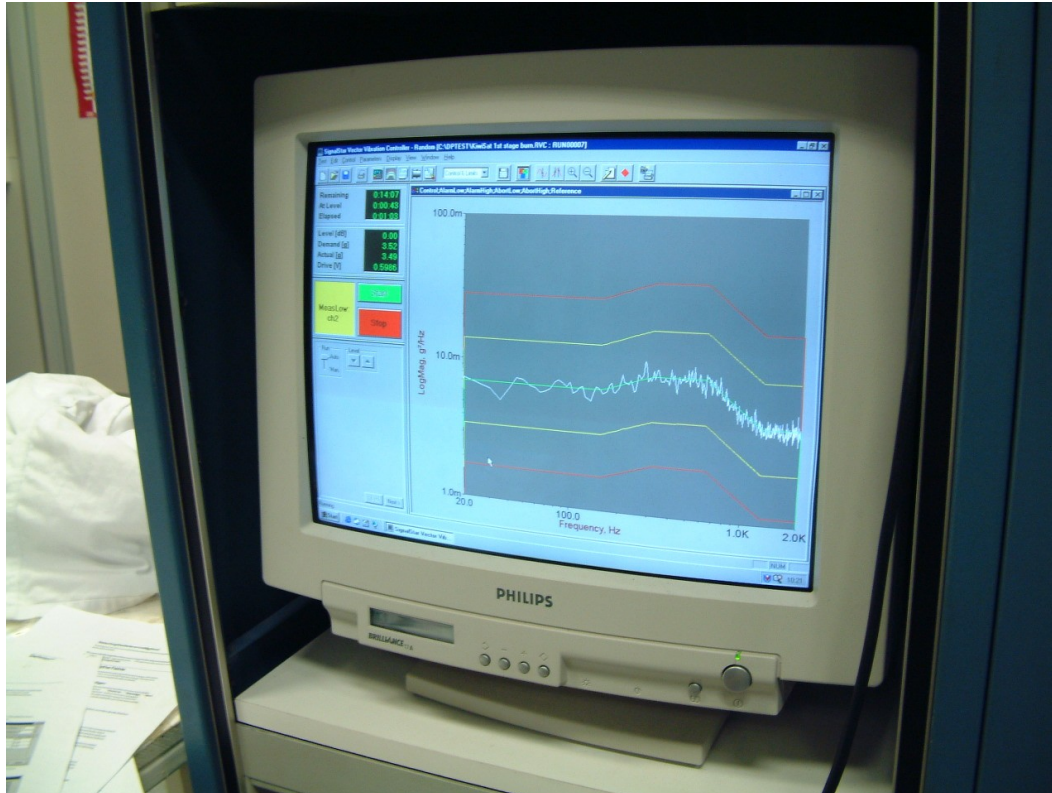
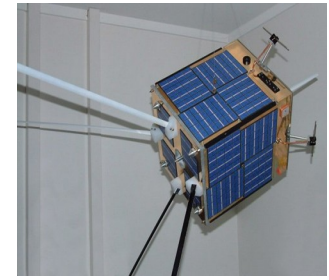


Fisher & Paykel
HEALTHCARE

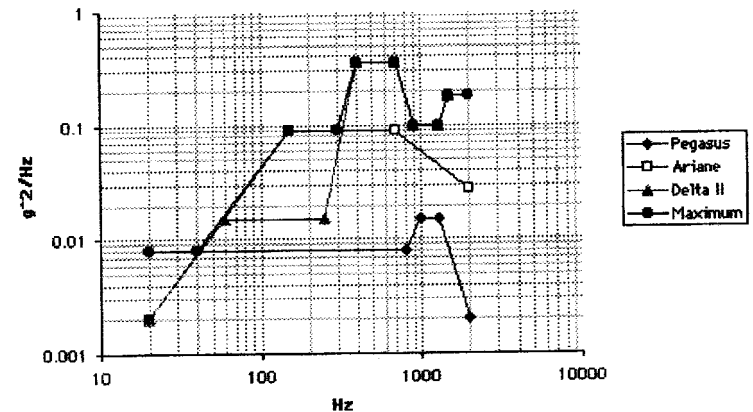




Test Equipments. Vibration Profile



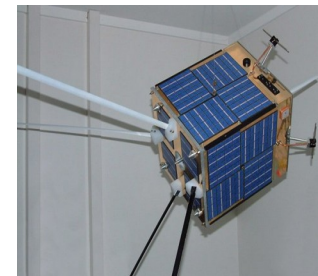
Launch Vehicle Random Vibe Profiles



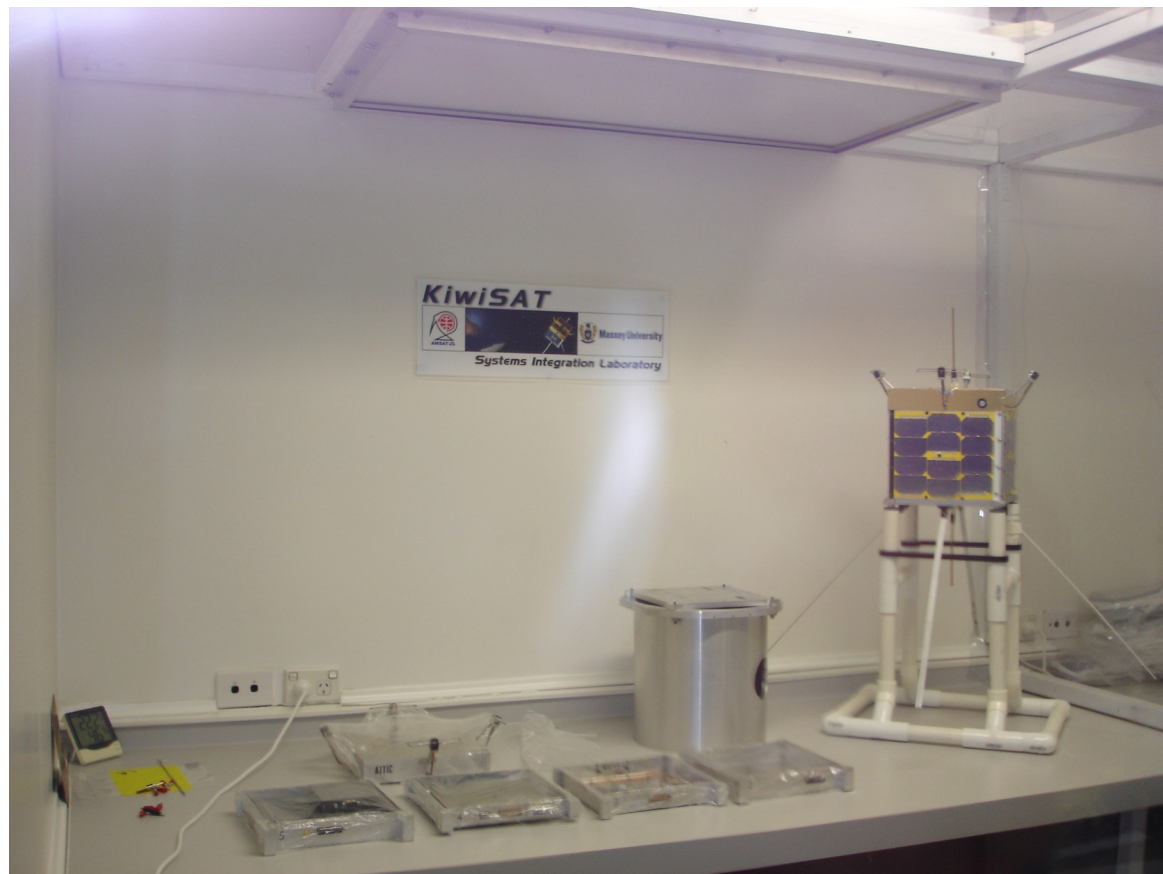
Actual 'lift-off' profile for Dnepr LV – 35 secs duration.



Clean Room



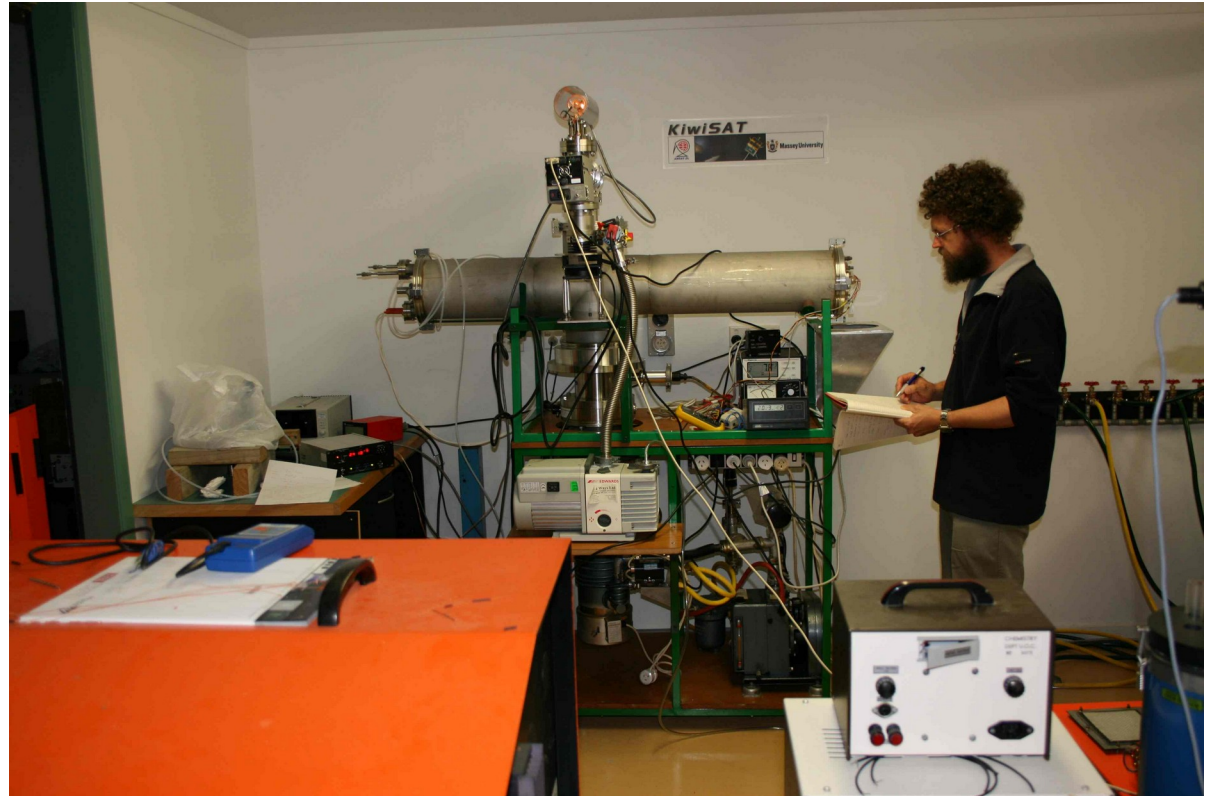
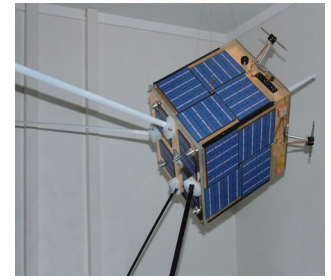
- First moves towards a “flat-sat” using the engineering trays.
- Currently the linear transponder is operating 24/7 using the clean room antennas

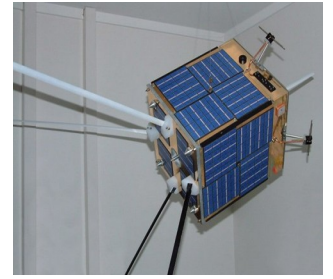


(The “sat” on the assembly stand is the model - s



Test Equipment. Vacuum/Thermal Chamber

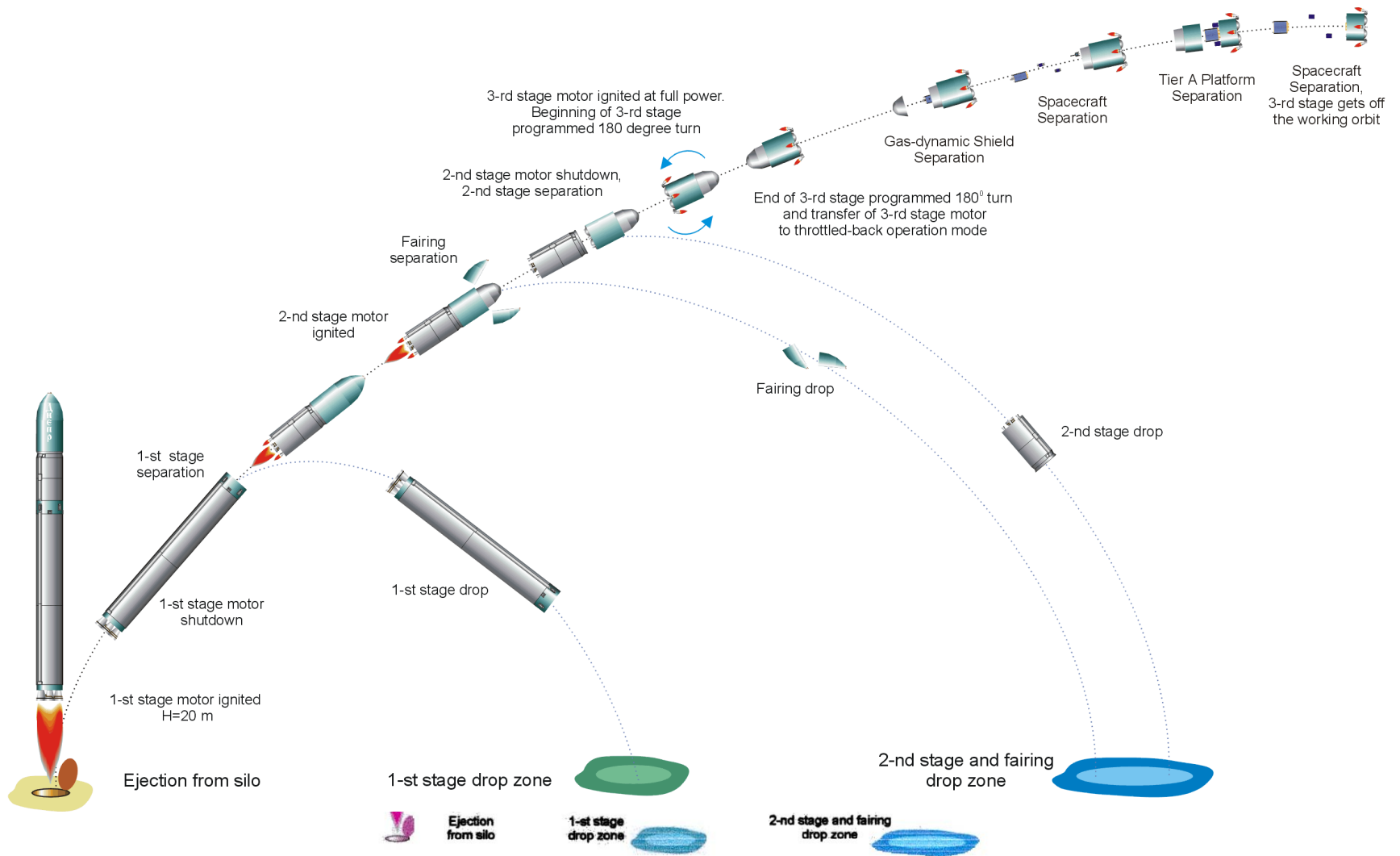




KiwiSAT – Launch proposals.

Russian DNEPR
Space launch system

KiwiSAT Launch Sequence

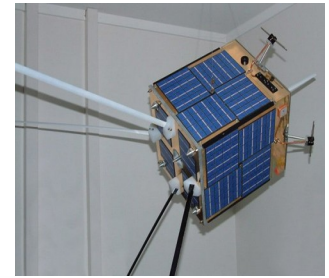


DNEPR
Lift-off!





AMSAT-ZL Would Graciously Accept and Appreciate Your Donation To KiwiSat



**Donations to help fund the various stages of KiwiSAT
development can be made by mail to the Treasurer of
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